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Overview of CHECWORKS

Jeffrey S. Horowitz, ScD
Vermont Yankee

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Background

- Surry Unit 2 accident – December 1986
- Demonstrated need to inspect single-phase piping
- Limited US inspection programs were in place for single-phase FAC
- EPRI & NUMARC commit to developing a computer program (CHEC) to assist in predicting piping wear in BWRs and PWRs
- NUMARC issued programmatic guidance
- CHEC evolved into CHECWORKS

CHEC Development Approach

- CHEC released 7 months after Surry accident
- Gathered data from Europe
  - Laboratory data from CEGB (England)
  - Laboratory data from EDF (France)
  - Plant and laboratory data from Siemens (Germany)
- All known laboratory data were obtained
- Used existing scientific knowledge to structure correlation between piping wear and plant operating parameters

Mathematical Analogue

- Following the Keller and Kastner correlations & the Berge model, a new correlation was designed and implemented.
- FAC Rate = $F_1 * F_2 * F_3 * F_4 * F_5 * F_6 * F_7$
- Where:
  - F_1 = Temperature factor
  - F_2 = Mass transfer factor
  - F_3 = Geometry factor
  - F_4 = pH factor
  - F_5 = Oxygen factor
  - F_6 = Alloy factor
  - F_7 = Void fraction factor (CHECMATE & CHECWORKS)

Improvements over previous approaches

- Use of the largest database of experimental and plant data.
- Incorporation of local conditions through water chemistry modeling (pH and dissolved oxygen), void fraction and flow modeling (velocity, pressure and enthalpy).
- Use of geometry factors from plant data with insight from copper modeling tests.
- CHECWORKS' correlation has been continually validated and refined, as necessary, against new data (plant and laboratory).

Input parameters

- **Heat Balance Diagram** – one time input
- **Global plant conditions** – power level, thermodynamic conditions, water chemistry and operating time for each operating period
- **Plant component conditions** – component geometry, material, size, wall thickness, operating and design conditions, flow rate and quality (if not from flow analysis)
- **Component replacement information** (if applicable)
- **Inspection data** (if applicable)

Plant Modeling

- The plant is divided into a number of lines having roughly the same water chemistry and operating conditions – e.g., feedwater between feedwater heaters.
- Depending on the complexity and amount of resistant material in the plant there are normally 25 to 50 of these "analysis lines."
- Using the global information, the wear is calculated for each operating period, and the lifetime wear of each component is calculated by summing up the calculated amounts of wear for each period.

How CHECWORKS works

- CHECWORKS is designed to handle:
  - Changes in operating conditions (e.g., flow rate)
  - Changes in water chemistry (e.g., oxygen concentration)

  Each change is defined as a separate operating period.

- The two basic design considerations are to:
  - Model changes in conditions, including the ability to forecast the impacts of such changes.
  - Handle inspected and non-inspected components.

- CHECWORKS is a tool to ***help select*** inspection locations.

How CHECWORKS works (cont.)

- Analysis without considering inspection data is known as Pass 1.
  - A Pass 1 analysis is typically used to select initial inspection locations.
- The user has the option to include inspection data – this is known as Pass 2.
- For Pass 2, the user can compare how well the program's predictions match the measurements.

Reconciling predicted and observed data

- Part of the Pass 2 feedback is the program-computed line correction factor (LCF).
- The LCF is computed separately for each Pass 2 line considered.
- The user also has the ability to see the resulting predictions versus measurements on various plots and tables allowing the identification and examination of any outliers.

Program outputs

- For each component, in each line analyzed, CHECWORKS provides:
  - Predicted wear rate
  - Predicted thickness
  - Predicted time to reach critical thickness
- For Pass 2 analysis, the LCF and measured thicknesses are also provided

CHECWORKS' Use as Part of a FAC program

- CHECWORKS alone is not a FAC program.
- Inspection locations should be chosen with the aid of CHECWORKS and other sources of data such as operating experience.
- The use of CHECWORKS together with participation in CHUG and the programmatic guidance of NSAC-202L have been successful in reducing the number and severity of FAC caused accidents.
- All three elements (CHECWORKS, NSAC-202L and CHUG) are necessary for an effective FAC program.

Thank you for your attention.

- Questions?

End of presentation